Uncertainty analysis of satellite aerosol products

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Till now, a number of remote sensing instruments have been providing aerosol datasets, such as historical sensors like Advanced Very High Resolution Radiometer (AVHRR), and modern sensors like Moderate Resolution Imaging Spectrometer (MODIS) and Visible Infrared Imaging Radiometer (VIIRS). Previous studies have found that the retrieved aerosol properties can have large bias especially in China, which is a densely-populated, heavily-polluted region in East Asia [1,2,3]. This is mainly due to the uncertainties in the retrieval algorithm, such as surface reflectance parameterization, aerosol type assumption, aerosol vertical distribution and cloud screening strategy. In this study, we discuss the uncertainties in the aerosol retrieval process from two aspects: aerosol vertical distribution and aerosol model assumptions. Firstly, we use the Second Simulation of the Satellite Signal in the Solar Spectrum (6S) atmospheric radiative transfer model to set up experiments and discuss the sensitivity of AOD error to the scale heights of aerosols by assuming three representative aerosol types, namely scattering fine particles, absorbing fine particles and dust. We also explore the effects of boundary layer in the AOD retrieval errors. The results show that AOD error is most sensitive to scale height for fine absorbing aerosols: ±1 km scale height error can lead to ~40% AOD retrieval error. And the sign of AOD bias can change from negative to positive with increasing surface albedo. Also, ignoring the boundary layer can result in ~10% AOD error. Secondly, we assess the sensitivity of AOD error to aerosol models by perturbing the single scatter albedo and asymmetric factor by ±0.03 according to their measurement uncertainties. The results show that an overestimation of SSA will lead to an underestimation of AOD and 0.03 SSA perturbation will cause errors as large as 30%. The effect of g factor is comparatively less. Finally, we made some improvements using lidar retrieved aerosol vertical profiles and reconstructed aerosol models in AOD retrieval in Beijing-PKU site especially in winter season: the overall correlation increases from 0.63 to 0.80 and mean bias decreases from 0.17 to 0.05.

References

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